Wildfire Risks to Assets

Fire is both a natural ecological force and common landscape agent of change throughout much of California. See the Assessment document Trends in Wildland Fire. This chapter analyzes how wildfire affects some of the biological, physical, economic, and social assets important to California. Specifically, the chapter focuses on fire risks to:

- people and property;
- ecosystem function and health;
- range forage;
- timberlands; and
- soils.

Photo courtesy of the Bureau of Land Management.

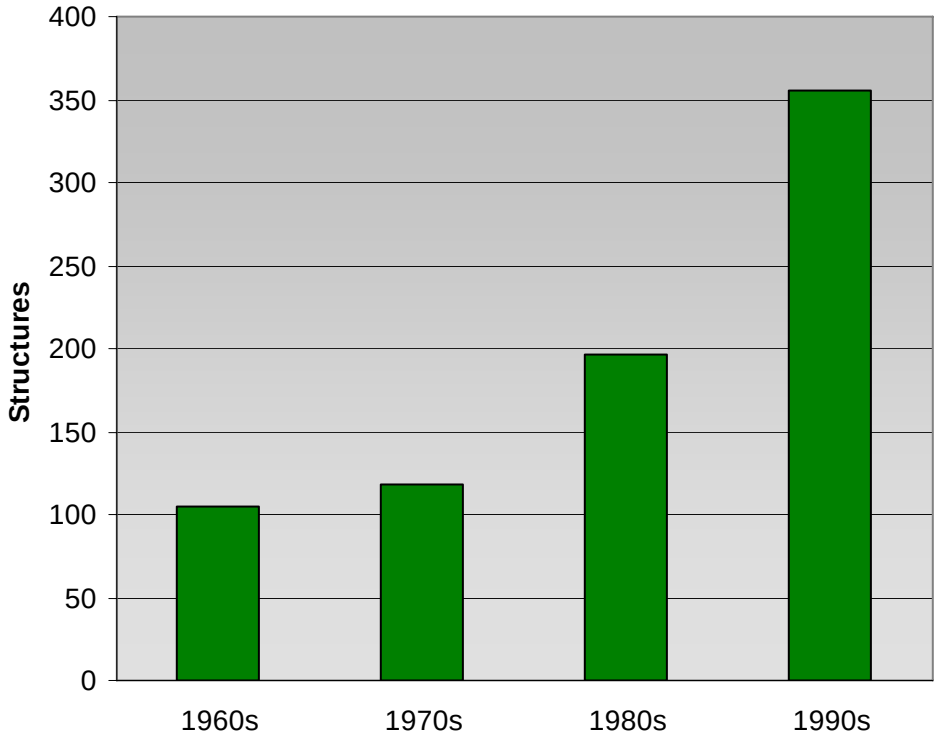
The term risk is used to define a potential damage or loss to a specific asset of concern. Risk for one particular resource may be fundamentally different than for another that is exposed to the same fire event. In this analysis, the causative agent (the fire event itself) has two principal components—the probability of the fire event and the characteristic magnitude of that fire event to cause change (Bachman and Allgower, 1999). The chance that a wildfire will occur is measured by an index of "expected fire frequency." The characteristic magnitude of the event is based on our measure of "potential fire behavior." Together these two measures comprise what we term "Fire Threat." All of these measures are part of the California Department of Forestry and Fire Protection (CDF) Fire Plan (CDF, 2003). See the Assessment document Trends in Wildland Fire.

Fire risks to people and property

A significant risk from fire is posed to the people and houses in California, as witnessed by an increasing trend in structure loss in wildland fires.

A significant risk from fire is posed to the people and houses in California, as witnessed by an increasing trend in structure loss in wildland fires (Martin and Sapsis, 1994) (Figure 1). These risks are not new. The so-called "Wildland-Urban Interface" (WUI) term has been in use for three decades (Fischer and Arno, 1988; Weise and Martin, 1994). WUI is a general term applied to all manner of configurations of development interspersed or adjacent to landscapes that support wildland fire. These physical settings have been widely acknowledged as a major issue for CDF's fire management since at least 1972 (State of California, Division of Forestry, 1972). The diversity of physical settings and disagreement about alternative mitigation strategies have led to increased confusion and different methods of defining and mapping the WUI. The work presented here is an attempt at an integrated analysis for Statewide and regional assessment to apply to local land use planning and pre-fire project development.

Figure 1. Mean annual structure loss from wildfire on State protected lands, by decade, 1960-1999



Source: CDF, various years

Defining Wildland-Urban Interface Areas

Much work has been done in assessing the threat of wildfire to California's WUI. Much of this is formalized in the California Fire Plan. Further efforts have also been made by CDF in context of the National Fire Plan.

The National Fire Plan and Wildland-Urban Interface communities in California: The 2000 fire year, which saw the largest fire season in the western United States in 90 years, induced the federal government to instigate a program dedicated to community and environmental protection from wildfire—the National Fire Plan (The National Fire Plan, 2003; Hann and Bunnell, 2001). See the online document Home Page of the National Fire Plan for more information. Some nationwide analyses were performed to meet the intent of the legislation authorizing the National Fire Plan, including the development of a listing of Communities at Risk for placement in the Federal Registry (The National Fire Plan, 2001). See the online document Communities at Risk. While these analyses followed very basic conceptual guidelines, they were actually conducted on a state-by-state basis under the authority given to the State Forester; therefore, in California this analysis fell under CDF's jurisdiction. CDF developed a final listing of Communities at Risk. Communities were assembled into groups that had significant fire risk and those that did not. Communities with significant fire risk were further grouped into those that had risk of fire coming from nearby federal lands and those that did not (see Communities at Risk). There is one ongoing Geographic Information System (GIS) based generic risk assessment for the lower 48 states and a related specific risk to flammable structure (house) analysis (U.S. Forest Service (USFS), 1999 and 2001). See the online documents Coarse-Scale Spatial Data for Wildland Fire and Fuel Management and Wildland Fire Risk to Flammable Structures, v2000 for more information.

The main limitations of this work are that no differentiation in risk was assigned to different communities on the list (i.e., all communities were equally at risk), and a community was defined by a point in space. Communities vary in the nature and extent of their assets, expected fire frequencies, and potential fire behavior (Fire Threat). Additional complexity for describing fire risks to communities is required to prioritize, delineate, and design effective mitigation strategies that will reduce losses of structures, harm to people, and other adverse impacts on individuals in California. As a result CDF has refined and expanded the original Community at Risk methodology, as presented in this section.

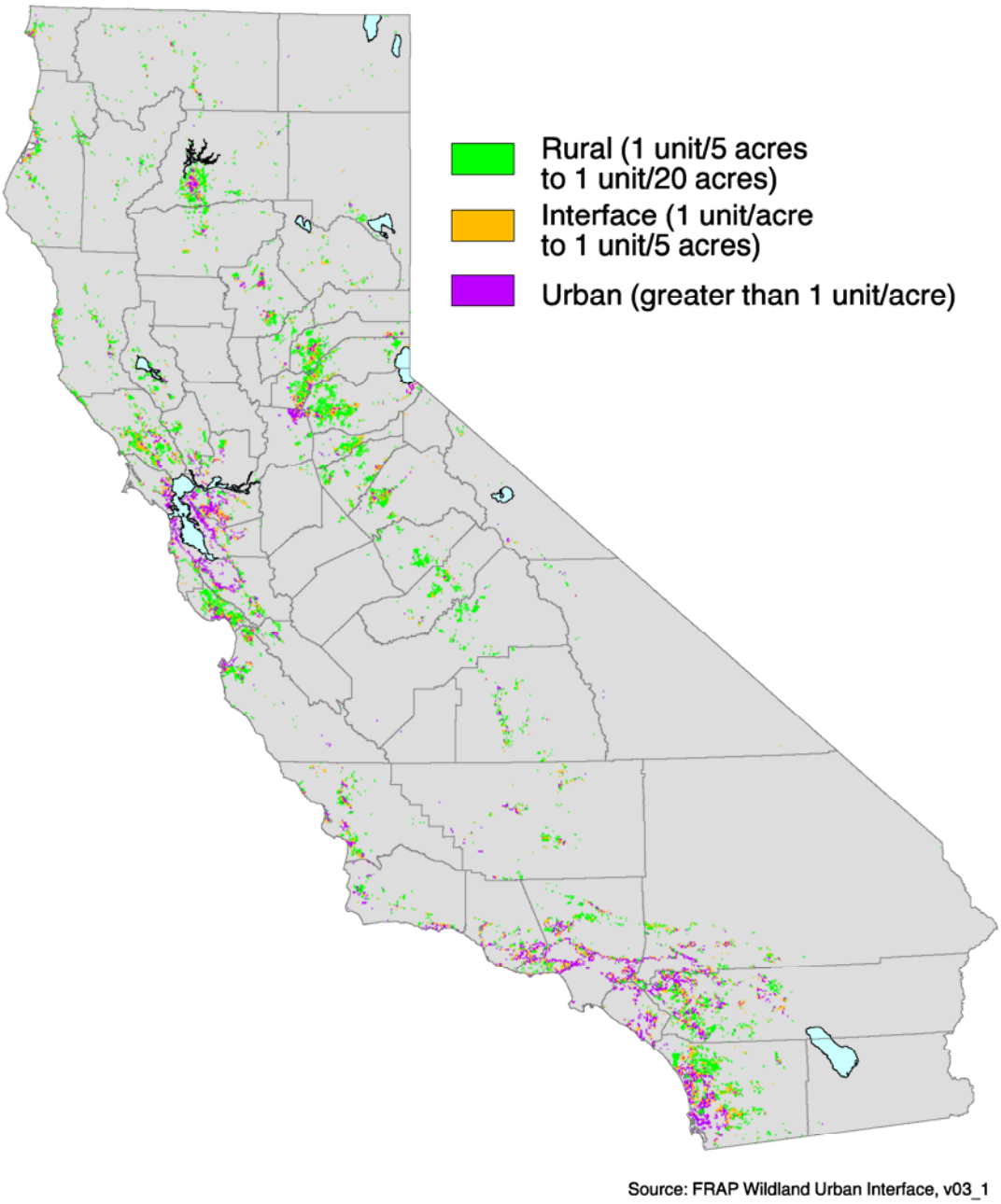
While this policy has resulted in a significant increase in funding designed to protect people and property from fire risks, there is still no clearly accepted risk assessment methodology for stratifying risk and determining project prioritization, design, and implementation.

CDF has developed an estimate of fire risk in the WUI that is consistent with the National Fire Plan methods, but is more refined both in terms of mapping extent and in terms of quantification of risk. Within California, both wildfire risk and asset characteristics can vary in the same area. To account for these multiple combinations, spatial data is used to distinguish fire-related characteristics from assets, and spatial rules are applied for determining relative risk of loss (see the Assessment document Assessment Information Systems). Levels of threats are indicated by terms such as High, Very High, or Extreme, with Extreme being the highest threat. This creates a map (or GIS spatial representation) of Fire Threats. A similar spatial representation of housing unit density based on the 2000 census data is superimposed onto the Fire Threat data. Housing unit density was classified into the following categories, where all classes other than wildlands are considered as potential WUI (Table 1, Figure 2).

Table 1. Housing unit density classes

Class	Description
Wildland	Less than one housing unit per 20 acres
Rural	One housing unit per five acres to one housing unit per 20 acres
Interface	One housing unit per acre to one housing unit per five acres
Urban	Greater than one housing unit per acre

Figure 2. Wildland urban interface (WUI) susceptible to High, Very High, and Extreme threat by housing unit density, 2000



Significant Fire Risk to WUI housing units = housing units in WUI in Extreme, Very High and High Fire Threat classes

Source: Fire and Resource Assessment Program (FRAP), 2003a

The basic concept is that housing unit density is a good proxy measure for asset value, people density, and level of community infrastructure at risk to fire damage. All other things being equal, an area labeled as urban is likely to represent more asset/social value than an area of equal size that is labeled

rural. One limitation of this approach, though not serious, is that areas of less than one housing unit per 20 acres do not show up as areas of significant community value.

The density data does a reasonably good job of showing where people are and at what spatial concentration. However, it is necessary to show how the threat to assets will vary by both the relative threat of wildfire and barriers to the spread of wildfire. This was done through a series of steps that take into account significant barriers to fire spread such as natural land features or land uses that act as natural barriers/fire modifiers (see the Assessment document Assessment Information Systems).

A Statewide summary of acres in the WUI by proximate threat class is listed in Table 2, and a summary of total number of housing units is listed in Table 3. Similar data summarized by bioregion and county can be found at Information and Data Center.

Table 2. Area of wildland urban interface by density class and fire threat, 2000 (thousand acres)

		Area of WUI by fire threat class (thousand acres)				
Density class	**Total acres**	**Extreme**	**Very High**	**High**	**Moderate**	**None**
Rural	3,126,844	459,507	1,733,775	392,808	475,188	65,564
Interface	1,322,621	249,996	722,877	176,144	156,197	17,406
Urban	3,391,217	209,799	909,622	609,386	1,608,606	53,802
Total	7,840,682	919,302	3,366,274	1,178,338	2,239,991	136,772

Source: FRAP, 2003a

A total of 7.8 million acres are developed at densities considered to meet the WUI criteria. Of this total, 920,000 acres are exposed to an Extreme Fire Threat, 3.4 million acres to a Very High threat, and an additional 1.2 million acres to a High threat. If we consider all WUI lands with threat levels greater than Moderate to be at significant risk to damage from fire, the total area at significant risk is 5.5 million acres, or 59 percent of the total WUI area. The density breakdown of this group shows that 1.7 million acres (32 percent) of the WUI at risk are Urban, 1.2 million acres (21 percent) are Interface, and the remaining 2.6 million acres (47 percent) are Rural.

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The distribution of housing units in WUI by housing unit density classes that are exposed to High or greater Fire Threat is shown in Table 3. As expected, while the majority of areas considered WUI are low-density rural areas, when viewed in terms of assets at risk, most housing assets are concentrated in urbanized areas. Of the 4.9 million homes exposed to High or greater Fire Threat, 4.1 million homes (84 percent) are in the Urban density class. The dominant density/threat class is the Urban/Very High threat class, comprising 2.1 million homes.

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Table 3. Housing units in the wildland urban interface by density class and fire threat, 2000

Density class	Total housing units	Housing units by fire threat class				
		Extreme	Very High	High	Moderate	None
Rural	323,284	49,167	178,491	41,793	47,842	5,989
Interface	597,498	109,892	316,246	83,347	80,000	8,012
Urban	10,886,540	380,220	2,131,667	1,624,185	6,627,360	123,104
Total	11,807,323	539,279	2,626,404	1,749,325	6,755,202	137,105

Source: FRAP, 2003a

Wildland-Urban Interface Zone of Influence

While defining and mapping WUI is key to prioritizing areas in need of risk assessment and mitigation measures, many strategies designed to protect these areas from wildfire concentrate on fuel treatment projects outside the immediate area of development. This requires additional analysis to determine the scope of area and key characteristics that might be used to define where mitigation work would best be suited. As these areas typically will be adjacent to WUI communities, they can be approximated by defining a "Zone of Influence" area around developed areas and describing key characteristics based on innate wildfire conditions—i.e., expected fire frequency and potential fire behavior (collectively, Fire Threat). This land allocation allows for inclusion of landscape level fuel treatments to be placed in a pattern that not only allows for reduced risk to WUI assets, but also broader ecological objectives of modifying fire effects in fire adapted forests, woodlands, and brushlands at the landscape scale (Weatherspoon and Skinner, 1996; Finney, 2001).

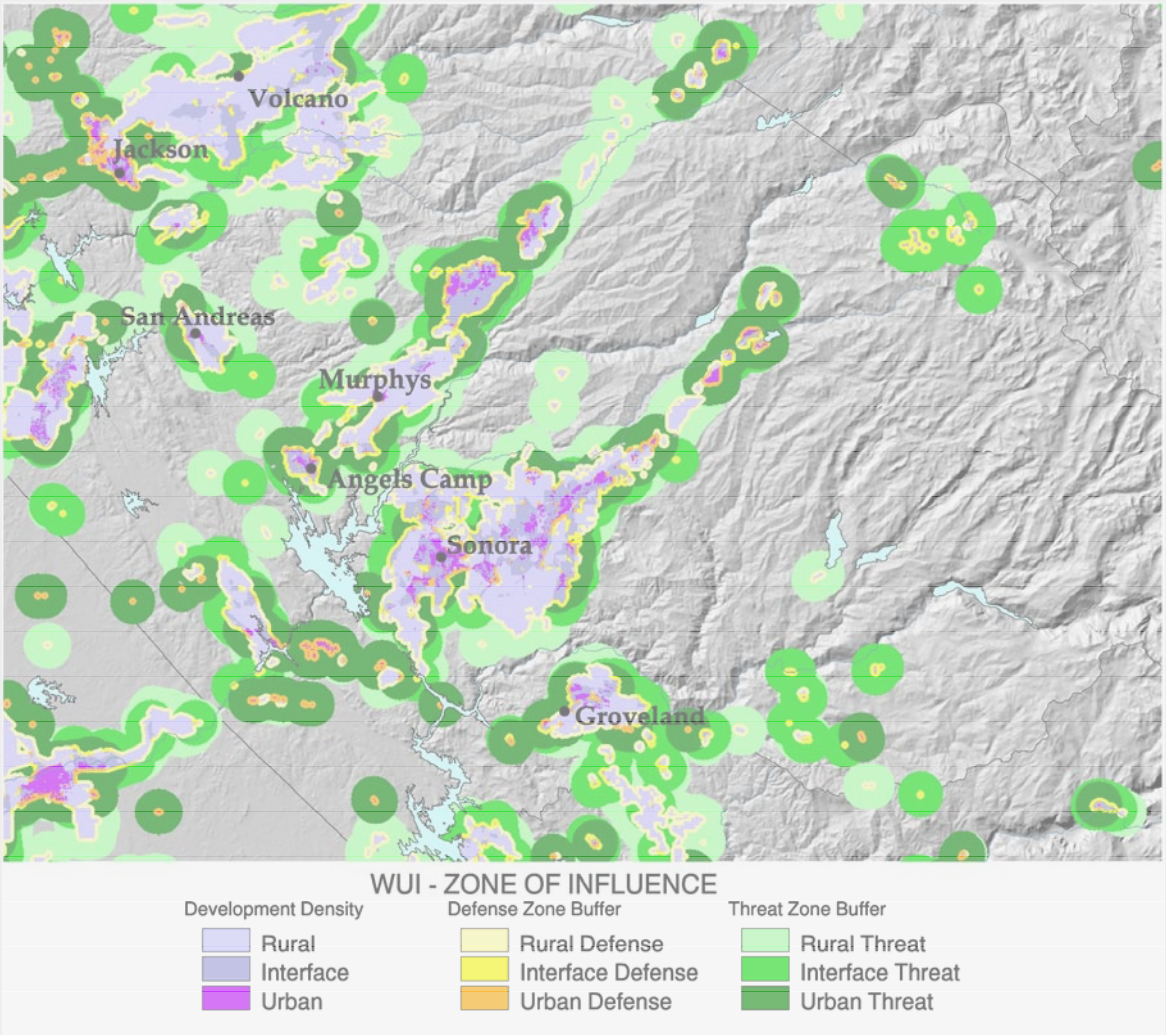
A total of one million acres in the WUI Zone of Influence are classified as Extreme Fire Threat, and almost half of this total exists around urban density areas. An additional 7.6 million acres are classified as Very High Fire Threat within the Zone of Influence.

Following similar methods developed at FRAP to assist the USFS in implementing the National Fire Plan and the Sierra Nevada Framework (USFS, 2003), CDF has identified Fire Threat classes by the Zone of Influence category (see sidebar, Wildland-Urban Interface Zone of Influence modeling). The data suggest that significant Fire Threat exists in close proximity to human development and that extensive areas may require treatment to mitigate hazard and reduce wildfire risks to people and property. A total of one million acres in the WUI Zone of Influence is classified as Extreme Fire Threat, and almost half of this total (460,000 acres) exists in buffers around urban density areas. An additional 7.6 million acres are classified as Very High Fire Threat within the Zone of Influence. Total acreage of each threat class in each Zone of Influence category is given in Table 4, with bioregional and county summaries available at Information and Data Center.

Wildland-Urban Interface Zone of Influence modeling: WUI Zone of Influence is modeled using a simple linear buffering model to define the zone as 1.5 miles from any developed cell (e.g., one with density greater than one house per 20 acres). Then it is assigned as being in the nearby defense zone (the immediate 0.25 mile area) or in the threat zone (the adjacent 1.25 mile area). The model assigns the labeling of these areas based on a priority of proximity (defense zone prioritized over threat zone) and then density (higher density prioritized over lower density). By including measures of both proximity and asset density exposed to wildfire risk, the classification is designed to allow for prioritization of treatments based on characteristics that would likely result in higher levels of risk reduction.

The resultant mapping shows developed areas based on their density class and the buffered Zone of Influence around the developed areas based on proximity and density nearby (Figure 3).

Figure 3. Example of Wildland-Urban Interface density and Zone of Influence mapping for the Sierra foothills region around Sonora (center of picture)



Source: FRAP, 2003a

Table 4. Threat class in Wildland-Urban Interface Zone of Influence buffer zones

Buffer Zone	Threat	Acres
Rural Defense	Not calculated	648,421
Rural Defense	Moderate	504,151
Rural Defense	High	593,557
Rural Defense	Very High	485,722
Rural Defense	Extreme	87,843
Rural Threat	Not calculated	933,401
Rural Threat	Moderate	1,182,937
Rural Threat	High	1,783,517
Rural Threat	Very High	1,294,896
Rural Threat	Extreme	209,011
Interface Defense	Not calculated	196,169
Interface Defense	Moderate	240,920
Interface Defense	High	269,683
Interface Defense	Very High	187,333
Interface Defense	Extreme	37,154
Interface Threat	Not calculated	638,888
Interface Threat	Moderate	1,026,619
Interface Threat	High	1,544,228
Interface Threat	Very High	1,127,917
Interface Threat	Extreme	201,573
Urban Defense	Not calculated	694,986
Urban Defense	Moderate	879,111
Urban Defense	High	410,622
Urban Defense	Very High	216,360
Urban Defense	Extreme	30,381
Urban Threat	Not calculated	4,144,382
Urban Threat	Moderate	4,193,532
Urban Threat	High	3,043,641
Urban Threat	Very High	2,218,502
Urban Threat	Extreme	432,677

Source: FRAP, 2003a